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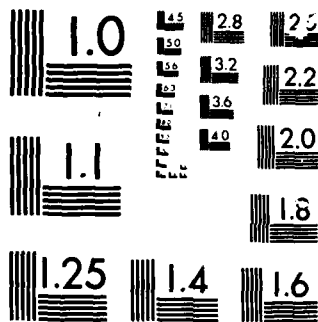
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**ASSESSING POSSIBLE DAMAGE DUE TO
RADIO FREQUENCY RADIATION**

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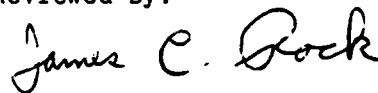

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TABLE OF CONTENTS

	Page
DD Form 1473	i
Acknowledgement	iii
I. INTRODUCTION	1
II. DISCUSSION	1
III. CONCLUSIONS	2
IV. RECOMMENDATIONS FOR EXAMINATION	3
References	5
Distribution List	6

I. INTRODUCTION

A. Purpose:

The purpose of this report is to assist base level physicians and other health care providers in assessing possible health effects due to radio frequency radiation (RFR) exposures.

B. Problem:

There is much confusion in the medical literature regarding RFR and its biological effects. Few health care providers have sufficient knowledge of the physical sciences to be able to determine the validity of many medical RFR studies. Because of these factors many medical reports on individuals thought to be exposed to RFR are either lacking in the scope necessary for complete examination, or more often, are unnecessarily broad. Worse yet, there is a tendency to attribute physical findings to RFR in the absence of any reasonable correlation of RFR and the finding. This report is written in the hope of alleviating some of these problems.

C. Scope:

This report will present basic information regarding RFR, its biological effects and some of the thinking behind the current Air Force RFR safety guideline, AFOSH Standard 161-9. Also included is a suggested Operating Instruction (OI) for a medical workup. It is intended as a clinical guide for clinicians and not as the final word on the science of RFR. Its contents must be viewed in this context.

II. DISCUSSION

Reading of AFOSH Standard 161-9, "Exposure to Radio Frequency Radiation," 12 October 1984 is recommended. This has a good section on biological effects and basic information pertaining to RFR. Also recommended are the ACGIH Threshold Limit Values Handbook; Documentation of the Threshold Limit Values; and USAFSAM-TR-83-1, Bioeffects of Radiofrequency Radiation.

RFR is considered to be that portion of the electromagnetic spectrum from 10 kHz to 300 GHz. At its upper end it blends with long wave infrared. It shares all of its physical characteristics with other segments of the electromagnetic spectrum; that is, it consists of component electric and magnetic fields propagated in space as waves. The interaction of these waves with matter depends on the wavelength, power and polarization of the wave and the size, shape, orientation and nature of the matter. In general, with regard to human beings, it can be said that the longer the wavelength the greater the depth of penetration into the body and the shorter the wavelength the less the depth of penetration. Wavelengths of 3 cm or less (10 GHz or more) are absorbed in the skin. Depth of penetration is only one factor; however, energy deposition is the key issue. In general, the greatest absorption in adult humans takes place at 70 to 80 MHz if they are not grounded and 35 to 40 MHz if they are. Specific conditions at the time of exposure may cause this

to vary. The mechanism for transfer of energy to human body by RFR is by vibration/rotation of dipole molecules, mainly water. The result is an increase in heat due to friction. An increase in temperature may or may not result depending on the thermoregulatory properties of the body. Since to date no robust effect of RFR has been demonstrated that does not relate to thermogenesis, and since varying wavelengths deposit varying amounts of energy, the concept of specific absorption rate (SAR) was developed. This is a measure of the rate of energy transfer to the body normalized to body mass and is equivalent to the power transferred. Heat generated is directly proportional to power absorbed. At a SAR of 4 W/kg the energy absorption within the human body may result in a detectable increase in core body or specific organ temperature of one centigrade degree or less. The only demonstrated effect in organs maintained at this increase over normal is a decrease in spermatogenesis due to heat. This decrease in spermatogenesis reverses on cooling. In addition, the body heat regulatory mechanisms of most normal individuals can adequately handle such loads. For comparison the average running man generates 5 W/kg of metabolic heat and the human heart muscle can generate 33 W/kg. To ensure safety, the Permissible Exposure Limit (PEL) was set at a SAR of 0.4 W/kg for frequencies above 3 MHz. This is averaged over any six-minute period. The curve of power density in mW/cm² versus frequency which will give a SAR of 0.4 W/kg can be found in the ACGIH TLV handbook. The same curve presented as a table can be found in AFOSH Std 161-9, 12 October 1984, entitled "Permissible Exposure Limits for Personnel."

In considering biological effects from the clinical standpoint, we should keep in mind the pre-eminence of thermal effects as the agent of damage. Cataracts and vacuoles have been produced in animal eyes with power densities equal to or greater than 100 mW/cm² delivered locally and acutely for 15 minutes or more. This correlates with temperatures in the eye of 41°C (106°F) or more. It has been difficult to produce cataracts in animals with whole body RFR without killing the animal. In animals overexposed directly to the eye all cataracts and vacuoles were present by the end of the third day.

At frequencies below 3 MHz the Air Force has adopted a maximum power density of 100 mW/cm². Air may become ionized at frequencies over 10 KHz at approximately 1,000 kV/m and can result in potentially hazardous electric discharges. Because of this the PEL contains a 100 kV/m limit which incorporates a safety factor of 10.

III. CONCLUSIONS

Specifically, then, we would look for thermal burn, signs of electric shock and/or burn, and fairly prompt cataract formation. Prompt evolution of clinical problems should be expected. In a review of 296 suspected cases of overexposure in the USAFOEHL accident file, only 58 were in fact exposed above the PEL. About half of the 58 (26) clearly felt a warming and terminated the exposure. Of those determined not to have been overexposed only 11% felt a warming sensation. By way of interpreting a warming sensation, 26 overexposed and 26 people not overexposed felt warming. This means that one is as likely as not to have been overexposed if warming is noticed. Conversely, if no warming is noticed there is only a 13% chance of having been overexposed.

Keep in mind also the safety factor of 10 in the PEL. Overexposure does not necessarily mean exposure to biologically meaningful levels.

IV. RECOMMENDATIONS FOR EXAMINATION

A. History:

1. Present Illness. Where possible include the following information:

a. Type of equipment involved in the exposure with model number and radio frequencies emitted.

b. Distance from the source to the person.

c. Length of time exposed.

d. If exposure was intermittent, then give longest individual time exposed as well as overall time period exposed.

e. Were any unusual noises heard in the ears?

f. Was a sensation of heat experienced and if so, where on the body?

g. What body parts does the person believe were exposed?

h. Does a previous history of RFR overexposure exist?

i. Does a previous history of overexposure to any chemical or physical agent exist?

2. Past Medical History.

a. List all types of work ever done, not only in the Air Force but previously, if applicable.

b. The remainder of the past medical history is standard.

3. Complete review of systems.

B. Physical Examination:

Systems of primary interest are the eyes and skin. The signs to be sought are cataracts and burns.

a. Eyes. Initial examination should describe the condition of the skin around the eyes as well as the eye itself. Slit lamp examination should be accomplished as soon as practicable. If any question is raised by slit lamp examination, referral should be made to an ophthalmologist for dilated slit lamp examination.

b. Skin. Observe for signs of heat-induced change and electrical burn. Note findings, to include negative findings.

c. The remainder of the examination should be as pertinent.

C. Laboratory Studies:

These should be as indicated.

No single test has any peculiar virtue. Routine tests, if done, should be limited to CBC and UA. Any others done should be for clinical reasons.

D. Referral:

If it is believed clinically necessary, referral for further workup of specific conditions should be accomplished within the usual medical referring system. Only very unusual circumstances would warrant referral outside the usual system. If there is a question regarding the need for referral or where it should be accomplished, consultation may be obtained from the USAFOEHL Occupational Medical Consultant at AV 240-2002, Commercial (512) 536-2002 or by electronic message.

E. Cautions:

1. These patients have a tendency to a great deal of anxiety based on their perceptions of an assault by an invisible agent. They're usually unfamiliar with the possible results of an overexposure and often have filled in the blanks of their knowledge with generalized fears of cancer and birth defects. Unless you can see an obvious connection between a finding and the exposure, other than a temporal one, the exposure and the finding are probably not connected. If you don't know, it is best to say that you don't but that you will find out.

2. Epidemiological studies to date have not demonstrated any long term consequences beyond those present at the time of the exposure.

3. Consultation may be obtained from the USAFOEHL Occupational Medical Consultant at Brooks AFB TX AV 240-2002.

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